- Fourth layer: underdrain system.

Sand Specifications

The sand in a filter shall consist of a medium sand with few fines meeting the size gradation (by weight) given in Table 6.5.2.C. The contractor must obtain a grain size analysis from the supplier to certify that the No. 100 and No. 200 sieve requirements are met. *Note: Many sand mixes supplied locally meet this specification. However, standard backfill for sand drains (as specified in the Washington Standard Specifications 9-03.13) does not meet this specification and shall not be used for sand filters.*

TABLE 6.5.2.C SAND MEDIA SPECIFICATIONS

U.S. Sieve Size	Percent passing
U.S. No. 4	95 to 100 percent
U.S. No. 8	70 to 100 percent
U.S. No. 16	40 to 90 percent
U.S. No. 30	25 to 75 percent
U.S. No. 50	2 to 25 percent
U.S. No. 100	Less than 4 percent
U.S. No. 200	Less than 2 percent

Geotextile Materials

Geotextile material requirements are summarized in Table 6.5.2.D (below).

TABLE 6.5.2.D GEOTEXTILE SPECIFICATIONS

Geotextile Property	Value	Test Method
Grab Tensile Strength, min in machine and x-direction	250 lbs/160 lbs min.	ASTM D4632
Grab Failure Strain, in machine and x-machine direction	<50%/>50%	ASTM D4632
Seam Breaking Strength (if seams are present)	220 lbs/140 lbs min.	ASTM D4632 and ASTM D4884 (adapted for grab test)
Puncture Resistance	80 lbs/50 lbs min.	ASTM D4833
Tear Strength, min. in machine and x-machine direction	80 lbs/50 lbs min.	ASTM D4533
Ultraviolet (UV) Radiation stability	50% strength min., after 500 hrs. in weather meter	ASTM D4355
AOS	0.43 mm max. (#40 sieve)	ASTM D4751
Water Permittivity	0.5 sec – 1 min.	ASTM D4491

Notes:

- Minimum values should be in the weaker principal direction. All numerical values represent minimum average roll value (i.e., test results from any sampled lot shall meet or exceed the minimum values in the table). Stated values are for noncritical and nonsevere applications.
- AOS: Apparent Opening Size is the measure of the diameter of the pores on the geotextile.

Underdrain Systems

1. Several **underdrain systems** are acceptable:

   - A central collector pipe with lateral feeder pipes in an 8-inch drain rock bed
   - A central collector pipe with a geotextile drain strip in an 8-inch drain rock bed
   - Longitudinal pipes in an 8-inch drain rock bed, with a collector pipe at the outlet end.

   In smaller installations a single perforated pipe in 8 inches of drain rock may be adequate.

2. The **maximum perpendicular distance** between any two feeder pipes, or the edge of the filter and a feeder pipe, shall be 15 feet.

   Intent: This spacing is required to prevent the underdrain system from backing up into the sand filter during the early life of the filter when high filtration rates exist.

3. All pipe shall be placed with a **minimum slope** of 0.5 %.

4. The **invert of the underdrain outlet** shall be above the seasonal high groundwater level. The *seasonal high groundwater level* is the highest elevation of groundwater observed.

   Intent: The underdrain must be able to remove standing water from beneath the sand. If standing water remains, the sand will remain saturated. This could cause depletion of dissolved oxygen and reducing conditions in the sand, allowing some pollutants to become mobile and be released from the filter to downstream receiving waters.

5. **Cleanout** wyes with caps or junction boxes shall be provided at both ends of all collector pipes. Cleanouts shall extend to the surface of the filter.

   a) A valve box must be provided for access to the cleanouts.

   b) The cleanout assembly must be water tight to prevent short circuiting of the filter.

   Intent: Caps are required on cleanout wyes to prevent short-circuiting of water into the underdrain system when the pond fills with water.

6. If a **drain strip** is used for lateral drainage, the strip must be placed at the slope specified by the manufacturer but at least at 0.5%. All drain strip must extend to the central collector pipe. Drain strips installations must be analyzed for conveyance because manufactured products vary in the amount of flow they are designed to handle.

7. At least 8 inches of drain rock must be maintained over all underdrain piping or drain strip, and 6 inches must be maintained on either side to prevent damage by heavy equipment during maintenance.

   Note: If drain strip is used, it may be easier to install the central collector pipe in an 8-inch ***trench*** *filled with drain rock, making the cover over the drain strip and the collector pipe the same thickness. In this case the pipe shall be wrapped with geotextile to prevent clogging. Use the same geotextile specification as given in* Table 6.5.2.D*, Page 6-113.*

8. A **geotextile fabric** shall be used between the sand layer and the drain rock and be placed so that one inch of drain rock is above the fabric.

   Intent: The position of the geotextile fabric provides a **transition layer** of mixed sand and drain rock. A distinct layer of finely textured sand above a coarser one may cause water to pool at the interface and not readily drain downward due to the greater capillary forces in the finer material.

Underdrain Materials

1. Underdrain **pipe** shall be minimum 6 inch diameter perforated PVC, SDR 35. One acceptable specification for perforations is as follows: 2 rows of holes ($^1/_2$-inch diameter) spaced 6 inches apart longitudinally (max), with rows 120 degrees apart (laid with holes downward). Other drain pipe may be used if it adequately drains the filter.

2. **Drain rock** shall be $1^1/_2$ to $^3/_4$ -inch rock, washed and free from clay or organic material.
3. If a geotextile drain strip system is used, the attached **geotextile fabric** should not be used, or the fabric side should be positioned away from the sand blanket. Geotextile is already required between the sand and drain rock layers, and must meet the specifications in Table 6.5.2.D (p. 6-113) to avoid clogging the filter prematurely.

Access Roads & Setbacks

1. An access road shall be provided to the inlet and outlet of a sand filter for inspection and maintenance purposes. Requirements for access roads are the same as for detention ponds (see Section 5.3.1.1, "Design of Access Roads" and "Construction of Access Roads").
2. The location of the facility relative to ***site*** constraints (e.g., buildings, property lines, etc.) shall be the same as for detention ponds (see Section 5.3.1). See Section 6.2.3 (p. 6-21) for typical setback requirements for WQ facilities.

Grass Cover

1. **No top soil** shall be added to sand filter beds because fine-grained materials (e.g., silt and clay) reduce the hydraulic capacity of the filter.
2. **Growing grass** will require selecting species that can tolerate the demanding environment of the sand bed. Sand filters experience long periods of saturation during the winter wet season, followed by extended dry periods during the summer. Modeling predicts that sand filters will be dry about 60 percent of the time in a typical year. Consequently, vegetation must be capable of surviving drought as well as wetness.
    - The grasses and plants listed in Table 6.5.2.E (below) are good choices for pond sides. They are facultative (i.e., they can tolerate fluctuations in soil water). These species can generally survive approximately 1 month of submersion while dormant in the winter (until about February 15), but they can withstand only about 1 to 2 weeks of submersion after mid-February.
    - The lower portion of Table 6.5.2.E lists grass species that are good choices for the sand filter bottom. They can withstand summer drying and are fairly tolerant of infertile soils. In general, planting a mixture of 3 or more species is recommended. This ensures better coverage since tolerance of the different species is somewhat different, and the best adapted grasses will spread more rapidly than the others. Legumes, such as clover, fix nitrogen and hence can thrive in low-fertility soils such as sands. This makes them particularly good choices for planting the sand filter bed.
3. To prevent overuse that could compact and potentially damage the filter surface, **permanent structures** (e.g., playground equipment or bleachers) are not permitted. Temporary structures or equipment must be removed for filter maintenance.
4. If the sand filter is located in a Sensitive Lake Protection Area, low phosphorus **fertilizers** (such as formulations in the proportion 3: 1: 3 N-P-K or less) or a slow-release phosphorus formulation such as rock phosphate or bone meal should be used.

Recommended Design Features

The following design features should be incorporated into sand filter designs where ***site*** conditions allow:

1. A **horticultural specialist** should be consulted for advice on planting.
2. **Seed** should be applied in spring or mid to late fall unless irrigation is provided. If the filter is seeded during the dry summer months, surface irrigation is needed to ensure that the seeds germinate and survive. Seed should be applied at 80 lbs/acre.
3. Slow-release **fertilizers** may be applied to improve germination; however, see requirements above for sensitive lake protection areas.

4. A sand filter can add landscape interest and should be incorporated into the project **landscape design**. Interior side slopes may be stepped with flat areas to provide informal seating with a game or play area below. Perennial beds may be planted above the overflow water surface elevation. However, large shrubs and trees are not recommended because shading limits evaporation and can inhibit drying of the filter surface. In addition, falling leaves and needles can clog the filter surface, requiring more frequent maintenance. *Note: Examples of areas with stepped side slopes can be found at the Ballard Locks in Seattle and at Luther Burbank Park on Mercer Island.*

5. If **recreational use** is intended, such as for a badminton or volleyball play area, the interior side slopes of the filter embankment should be no steeper than 3:1 and may be stepped as shown in Figure 6.5.2.C (p. 6-123). Drainage tracts may be credited for up to 50 percent of the onsite recreation space requirement under certain conditions. Refer to King County Code 21A.14.180.D for recreation requirements (see Section 5.3.1.2).